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ABSTRACT

The study examined three questions regarding severely physically and communicatively handicapped children: (1) who are involved in developing and disseminating microcomputer technology? (2) what innovations are being researched, developed, and implemented? and (3) how is microcomputer technology being implemented by educators, administrators, and students? The dissemination networks of governmental organizations, schools, and other organizations in Britain and the United States are described. Innovations in hardware and software are described in terms of alternative input devices and switch controls, educational programs and software development, and computers as communicators. Four specific problems are noted: lack of programmers/educators, lack of networking among professionals, lack of sufficient funding, and lack of quality hardware/software. The appendixes include a glossary; an extensive list of researchers and organizations, mainly British; additional charts and figures, including a comparison of the advantages and disadvantages of using computers in the classroom; and an eight-page list of references. (CL)

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HANDICAPPED CHILDREN

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An InterFuture Project Studying

Applications of Microelectronic Aids in the Communication & Education of Severely Physically & Communicatively Handicapped Children

William H. Burns VI

31 January 1985

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APPLICATIONS OF MICROELECTRONIC AIDS IN THE COMMUNICATION & EDUCATION OF SEVERELY PHYSICALLY & COMMUNICATIVELY HANDICAPPED CHILDREN

An InterFuture Research Project

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ABSTRACT

This study is concerned with current applications of microcomputer technology in the communication and education of severely physically and communicatively handicapped children in the United States and England. Special attention is devoted to answering the following three questions: "Who" is developing this technology and making the decisions directing its dissemination? "What" technology is being developed and implemented? "How" is this technology being implemented?

To complement the research monograph, this paper includes an extensive Glossary of Specialized Terms (Appendix A), Researchers and Organizations Cross-reference (Appendix B), several useful figures (Appendix C), and a bibliography. These features should prove useful to future researchers in the areas of special education and microcomputer technology.

It is hoped that this study will catalyze a fuller understanding of the cultural differences between the United States and England. With this increased awareness, American and English special educators and computer technologists should be able to develop more effective policy regarding the use by handicapped children of microelectronic aids.

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DEDICATION

To the memory of

RICHARD BIEL

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INTRODUCTION

Inherent in the American political ideology of democracy and the social ideology of the equality of humanity is the ideal that all American students are entitled to equal educational opportunities. In Britain, because of the amount of socialization that has occurred, similar educational equality is guaranteed.

Educational opportunity in the United States was extended to include exceptional students--handicapped students, students with learning disabilities, and gifted students--in Public Law 94-142, the **Education for All Handicapped Children Act of 1975** (Kirk & Gallagher, 1979, p. 474). In the United Kingdom, a parallel piece of legislation may be found in the **Education Act of 1981** (Grubb, 1982, p. 308). Both of these acts will be discussed in greater detail in the section entitled **An Overview of Education Legislation**; presently, it is important to note the American and British legislative mandates to educate handicapped children.

In this age of increasing dependency upon computers in all aspects of daily life, it is easy to predict that computer literacy will soon become just another skill that must be mastered, like driving a car or using a telephone. However, because the computer holds such promise and a communication and education act for the handicapped, it is

perhaps more important that they be provided with the necessary equipment, so as to normalize their experiences as much as possible.

In two such technologically advanced countries as the United States and England, how can the withholding of such necessary technology be justified? Certainly, it cannot. It was estimated in 1979 by Dr. E. Paul Goldenberg, formerly of the Massachusetts Institute of Technology (MIT), that nearly 100,000 physically disabled individuals with adequate sensory, perceptual, and cognitive capabilities for language are unable to communicate vocally as a result of their condition, and nearly 300,000 individuals are unable to write (Goldenberg, 1979, p. 13). Goldenberg based these estimates on figures derived at the Bureau of Education for Handicapped Conference on Communication Aids for the Severely Physically Handicapped.

Although severely physically and communicatively handicapped individuals represent a small percentage of the overall population (see Figure 11 in Appendix C for statistics concerning the prevalence rate of handicaps in American school-age children), they represent a subpopulation that can be assisted in dramatic ways with very little effort or expense. The technology for enriching these person's lives exists today and is--through the efforts of concerned government officials, computer technologists, and special educators--being directed to ameliorate the problems that currently exist. This study

recaps the programs and organizations that have been instituted for this purpose.

Each of us bears the responsibility for seeing that each individual living in a society be provided with the fruits of that society. It is for this reason that research in the area of microcomputer technology for the handicapped is of the highest priority.

RESEARCH DESIGN AND METHODOLOGY

To most effectively answer the three subquestions outlined in the Abstract of this study--who is involved in the development and dissemination of microcomputer technology?; what innovations are being researched, developed, and implemented?; and how is microcomputer technology being disseminated?--a basically structural-functional research design was adopted. Using this strategy, it was possible to investigate the organization and operation of vital components in the special education microelectronics dissemination networks in the United States and in England. The major research methods, or modes of information-gathering, employed were participant observation, interviewing (structured and unstructured), and literature review.

In investigating who is developing microcomputer technology and making the decisions directing its dissemination, the main research method used was interviewing. Most of the people interviewed were government education officials, special education teachers, special education administrators, or students. These people were attached, for the most part, to three types of organizations: 1) special education schools (state and private); 2) government agencies (state and regional); and 3) other organizations (i.e., parents' groups, special

interest groups, academic groups, etc.). The main government agencies contacted were the Cerebral Palsy Foundation (US), the Spastic Society (England), Special Education Microelectronic Resource Centres (SEMERCs), the Council for Educational Technology (CET), and Communication Aids Centres (CACs).

Finding out what hardware and sofware innovations are being developed and implemented was accomplished through two research methods: interviewing and participant observation. Because this facet of the research was technical, the interview subjects were computer engineers, software developers, rehabilitation engineers, and applications programmers, in addition to special education teachers and administrators. Another very important aspect of research into this subquestion involved the observation of students using microcomputers and microelectronic aids in classroom settings. In many cases, it was possible to interview the students themselves (often through the use of microelectronic aids!) concerning the equipment with which they were working.

To determine how microcomputer technology is being implemented in special education, three research methods--interviewing, participant observation, and literature review--were employed. The main objective in answering this subquestion was to analyze the networks which have developed for the dissemination of microcomputer technology. An intensive literature review in both countries included

governmental publications, school publications, periodicals, and scholarly works in special education, computer technology, and related fields.

In his standard textbook Sociology, Erich Goode describes the basic propositions of the theory of structural-functionalism, or functionalism. When applied in sociologically based research, the propositions can be paraphrased as follows: society as a whole is composed of interrelated, mutually dependent parts, and these parts work together to maintain stability within society; societies develop institutions that are adaptive and that insure survival; social phenomenon should be examined in terms of their consequences; and dysfunctional activities or institutions threaten the capacity of a society to survive, and such activities or institutions tend to be controlled or eliminated (Goode, 1984, p. 18). The theory of structural-functionalism was the framework within which this study was conducted; throughout this paper, significant points which support or refute this theory are noted.

An Overview of Education Legislation

In the United States, legislation that mandated the education of handicapped children culminated in 1975. The stated goal of the **Education for All Handicapped Children Act of 1975** (P.L. 92-142), excerpted from the act itself, is the following:

> . . . to assure that all handicapped children have available to them . . . a free, appropriate public education which emphasizes special education and related services to meet their unique needs. (italics mine)

To that end, the United States government authorized the spending of up to $3 billion by 1982 (Kirk, 1979, p. 474); by 1978 the total government investment neared $1 billion and all the factors necessary for a successful educational system, including research, development, and extensive teacher training, were provided for (Kirk, 1979, p. 476).

Following the counsel of the Warnock Committee (see Kirk, 1979, p. 22)--which had been appointed in 1973 by the British Parliament to review the educational provisions for handicapped children in England, Scotland, Northern Ireland, and Wales--Parliament passed the **Education Act of 1981**. The act, according to Section 2(c), is directed toward

> . . . the need for securing that special educational provision is made for pupils who have special educational needs (**Education Act of 1981**).

One result of this act was the formation of the Microelectronics Education Programme (MEP), the stated aim of which was "[helping] schools to prepare children for life in a society in which devices and systems based on microelectronics are commonplace and pervasive" (Grubb, 1982, p. 309). The MEP is discussed extensively in this report in the section entitled **Governmental Organizations.**

Like its American counterpart, the British act stressed individual special education based on specific learning disabilities, rather than stressing the use of labels and categorization into handicap groups. This trend toward individualization was welcomed by the handicapped community, as it allowed the formation of "individual education plans" (IEPs), tailored to fit the needs of each particular student (Kirk, 1979, p. 475). The benefits of an IEP system over a general educational system in which multiply handicapped students are educated according to plans for their most serious handicaps are clear.

The impact of the above two pieces of legislation cannot be overstressed. Both acts stand out as landmarks on the horizon of special education; hopefully, however, they are only prototypes for forthcoming legislation. Since the passage of P.L. 92-142 in 1975, the United States Supreme Court has heard only one case involving this statute. Unfortunately, in the case of Board of Education (of the State of New York) vs. Rowley ("Excerpts...," 29 June 1982, p. B4), the court overturned several lower court rulings and

in effect ruled against handicapped students. The decision concerned a deaf fourth-grader, Amy Rowley, in Peekskill, NY. Lower courts had agreed with her parents' contention that the school district, in accordance with P.L. 92-142, should provide Amy with a sign-language interpreter for each of her classes. Writing for the majority, Associate Justice William H. Rehnquist stated the act's purpose as

> more to open the door of public education to handicapped children on appropriate terms than guarantee any particular level of service once inside ("Excerpts...," 29 June 1982, p. B4).

Contrarily, Associate Justice Byron R. White states,

> Because Amy was provided with some specialized instruction from which she obtained some benefit, she was receiving a meaningful and therefore appropriate education. This falls far short of what the act intended ("Excerpts...," 29 June 1982, p. B4).

After the landmark Rowley decision, the United States Department of Education decided to "reconsider" P.L. 92-142 (Brooks, 1982, p. 31). This reconsideration, which is not yet complete, seems to be aimed at protecting the rights of handicapped students while reducing administrative burdens. Many special educators are fearful that this will be accomplished by relinquishing many federal powers and decisions to the individual states. The resultant heterogeneity in programs, it is feared, would prove counter-productive to the great strides made by special educators in the recent past.

Severely Physically and Communicatively Handicapped Children

Because this study deals with severely physically and communicatively handicapped children, it will be necessary to describe these types of handicaps. One particular subgroup of handicapped individuals to which special attention will be paid are victims of cerebral palsy (CP). Most of these people suffer from physical and communicative disabilities. It will be shown how previous research has indicated that microcomputer technology can be utilized as an effective communication and pedagogic tool by cerebral palsied individual.

Cerebral palsy, contrary to popular belief, is not a disease; rather, it is a blanket term which encompasses various motor disorders resulting from cerebral damage (Kirk, 1979, pp. 439-440). For this reason, cerebral-palsied children, of all handicapped children, manifest the greatest variety of multiple handicaps. Because cerebral palsy may be caused by a great variety of prenatal, perinatal, and postnatal factors, mental retardation is not an automatic consequence of CP; only an estimated 50% of cerebral-palsied children have intelligence quotients (IQ's) under 70 (Hopkins, Bice, & Colton in Kirk, 1979, p. 442). Using the categories established for mentally retarded (MR) students, students with IQ's between 50 and 80 are considered "educable mentally retarded" (EMR). Approximately 80% of EMR

adults are capable of doing unskilled or semiskilled work (Wolfe in Kirk, 1979, p. 374).

An obstacle greater than mental retardation in the education of CP children is communication--an estimated 70% have serious speech defects, 28% have subnormal vision, and 13% have hearing disorders (Hopkins, Bice, & Colton in Kirk, 1979, pp. 443-444). However, an even more seemingly insurmountable obstacle to special educators is the physical immobility and lack of coordination shown by cerebral-palsied children. It was precisely these obstacles that the Department of Artificial Intelligence at the University of Edinburgh vowed to overcome. Early reports from the Edinburgh Project; the Brookline, Massachusetts Logo Project; and the Cotting School (Boston, Massachusetts) program indicate that microcomputers can function for the physically handicapped in much the same fashion as eyeglasses function for the sight-impaired. This analogy, discussed at length in the section of this study entitled **E. Paul Goldenberg's American Classification**, stresses the fact that the computer is merely an aid: glasses do not cause one to see; they aid one in seeing. Similarly, computers will not make the cerebral-palsied learn; they will aid them in learning.

In the past, because of rigid categorization, education of CP children was extremely difficult. The practice of labeling proved detrimental --first, because it tended to

cause educators to ignore other needs of the student; and second, because of the lack of uniformity in categorization. For CP alone, five distinct systems of classification exist, based upon type (spasticity, athetosis, ataxia, tremor, and rigidity); number and location of limbs involved (monoplegia, hemiplegia, triplegia, paraplegia, quadriplegia, diplegia, and bilateral hemiplegia); time of onset or manifestation (prenatal, perinatal, and postnatal); degree of involvement (slight or mild, moderate, severe, very severe); and other disorders involved (hearing disorders, visual disorders, perceptual disorders, intelligence disorders, and speech disorders) (Smith & Neisworth, 1975, pp. 377-379).

Besides categories of physical disability, categories of educational disabilities have also been developed. In the United Kingdom, the most notable categories are LD, ESN(M), and ESN(S), abbreviations for Learning Disabled, Educationally Subnormal (Moderate), and Educationally Subnormal (Severe), respectively.

Labeling a child an "ESN(S) spastic triplegic" certainly says very little about his or her specific educational needs and abilities. With the advent of IEP's and the trend towards individualized education, the technology which we now have at our disposal will hopefully be applied in a more just and productive manner.

The Role of Motor Learning in the Development of Cognition

One of the most widely held theories about intellectual growth states that early motor development is the root of all cognitive development. Goldenberg points out that although these theories vary slightly with each proponent, they

> all make the plausible assumption that each new cognitive achievement is built into the solid foundation of those that preceded it, ultimately depending on the earliest on cognitive achievement: voluntary motor activity (Goldenberg, 1979, p. 39).

The most influential theorists in the area of cognitive development include Bruner, Kephart, and Piaget.

According to Bruner (1964):

> It is fruitful . . . to distinguish three systems of processing information by which human beings construct models of their world: through action, through imagery, and through language. . . . I shall call the three modes of representation . . . enactive representation, iconic representation, and symbolic representation. Their appearance in the life of a child is in that order, each depending upon the previous one for its development. . . . By enactive representation, I mean a mode of representing past events through appropriate motor response ([Goldenberg's emphases], Bruner cited in Goldenberg, 1979, p. 39).

The clear consequence of Bruner's theory is that iconic and symbolic representation must remain undeveloped as long as the child is unable to represent "past events through

appropriate motor response."

Kephart (1971) explains the role of motor learning in the development of perception and cognition in the following terms:

> The early motor or muscular responses of the child, which are the earliest behavioural responses of the human organism, represent the beginning of a long process of development and learning. Through these first motor explorations, the child begins to find out about himself and the world around him, and his motor experimentation and his motor learning become the foundations upon which such knowledge is built. In early childhood, mental and physical activities play a major role in intellectual development. To a large extent, so called higher forms of behaviour develop out of and have their roots in motor learning. . . . **Perception is matched to motor, not the reverse.** It is important that the match be made in the proper direction ([Sandhu's emphasis], Kephart cited in Sandhu, 1983, p. 16).

Another important theorist who postulates that "doing is the best route to understanding" is Piaget (1971). He states:

> Knowledge is derived from action. . . . To know an object is to act upon it and to transform it. . . . To know is therefore to assimilate reality into structures of transformation, and these are the structures that intelligence constructs as a direct extension of our actions (Piaget cited in Goldenberg, 1979, p. 41).

The theories discussed above--that motor learning precedes and is a necessary prerequisite for cognitive development--has been largely accepted by American and British researchers, including British investigators Itard,

Sequin, Hebb, Harlow, Bower, Bryant, and many others (Sandhu, 1983, p. 15).

For the educator of handicapped children, the obvious question in light of the theories presented above is: How can physically handicapped children achieve the motor skills necessary for perceptual and cognitive development? This study has proved that the microcomputer and microcomputer-based aids can serve as a prosthetic in this process. This relationship is developed in detail in the section of this study entitled **Early Microcomputer Applications in Special Education.**

The Philosophy of Special Education

One question which lies at the basis of all special education deals with the definition of the word "normalize." Both E. Paul Goldenberg, in his book **Special Technology for Special Children,** and Jim Sandhu, in his report **The Use of Microelectronics in the Education of ESN(S) Children,** distinguish sharply between **normalizing behavior** and **normalizing experience** (Goldenberg, 1979, pp. 30-32 & Sandhu, 1983, pp. 11-15).

Normalizing behavior attempts to modify the actions of handicapped children to model the actions of non-handicapped children. This often proves frustrating to teachers and students alike and can actually interfere with the education

process. Jim Sandhu speaks very frankly on this topic:

> What society expects from the handicapped, and how it views their role, will to a great extent determine the "education" they receive. If the overriding aim is to turn them, as far as possible, into inoffensive, productive second-class citizen, then behaviour modification is undoubtedly the only useful technique (Sandhu, 1983, p. 11).

A useful analogy to describe the normaliation of behavior is offered by Goldenberg. If attempts are made to normalize the communication behavior of a deaf child, it would mean stressing the development of speech skills. Speech is, after all, the way normal people communicate. But what happens if the child's speech skills are not sufficient? Why not concentrate on developing a fluent and easy communication system--like signing--for the child?

Normalizing experience is exemplified in the suggestion to develop the deaf child's signing skills. Non-handicapped students enjoy the experience of communicating in a fluent and easy manner, and handicapped students should be able to live through these experiences. Today, technology has advanced to a point where the normalization of the handicapped child's environment is a viable option. Generally, the option of normalizing experience should be chosen over normalizing behavior.

The Warnock Committee of the British Parliament has stated that the ultimate aim of education of the handicapped is to

> increase a child's knowledge of the world

> he lives in and his imaginative understanding, both of the possibilities of that world and of his own responsibilities in it, and, secondly to give him as much independence and self-sufficiency as he is capable of (Warnock Committee cited in Sandhu, 1983, p. 12).

The main philosophy behind education of the handicapped should be, then, to increase autonomy as much as possible through a mixture of behavior modification and environment/experience normalization. To carry Goldenberg's analogy to its logical conclusion, the "ideal" method of educating the deaf child in the example may be in an environment where sign is the accepted form of communication, but in which oral skills are heavily stressed. This synthesis of behavior normaliztion and experience normalization is crucial to contemporary special education. Microcomputer technology can certainly help normalize the child's environment, thereby normalizing experience to some extent.

MICROCOMPUTER APPLICATIONS IN EDUCATION

An Overview of Educational Computing

Having been charged with the duty of providing special education for exceptional students, education officials and special education teachers and administrators began to develop syllabi to meet the varied needs of their exceptional students. With the utilization of computers and computer based aids in the regular classroom becoming more prevalent, many researchers began to examine the specific benefits of microcomputer technology in the special education classroom (cf. especially Foulds, Goldenberg, Papert, Sandhu, Valente, and Weir and Figures 1 and 2 in Appendix C of this study).

To describe the general ways in which microcomputers are being used in American and British special education classrooms, the categories presented by E. Paul Goldenberg, formerly of the Massachusetts Institute of Technology (hereafter, MIT), and Daniel Chandler, of the Microelectronics Education Programme (hereafter, MEP) will be delineated. These divisions, although neither exclusive nor exhaustive, have been popularly accepted in academe and merit further discussion. Differences and similarities between the two methods of classification will also be noted.

E. Paul Goldenberg's American Classification:

In his book **Special Technology for Special Children**, E. Paul Goldenberg presents three ways in which computers may be used in education: as tutor, as eyeglasses, and as mirror (Goldenberg, 1979, pp. 25-28). The distinction between implementing microcomputers as "tutors" and as "eyeglasses" is a very important one, and represents what have been viewed as the worst and best applications respectively.

Using computers as "tutors" is the application that most people think of when they think of microcomputers in the classroom; it is usually called computer-assisted instruction (CAI) in the United States. In this mode, the student works through programs at his or her own speed, advancing to the next level of difficulty when the computer determines that sufficient proficiency has been demonstrated. Goldenberg refers to programs of this type as the "hospital model" because they are concerned mainly with testing, screening, and diagnosis (Goldenberg, 1979, p. 26). Drs. Peter Goodyear and Annette Barnard of Aston University (Birmingham, England) have termed this type of education as "teacher-centred," as opposed to more desirable "student-centred" education (Smith, 1982, pp. 66-67). The basic problem with this type of application is that it is the student who is programmed by the computer, rather than that

student who is programming the computer. Goldenberg comments:

> Serious risks attend this model. . . . Thus, whenever our goal for a child is to build his [or her] autonomy and initiative, this model is counter-productive. At the best, progress toward autonomy is superficial; at the worst, it is undermined altogether. For the handicapped person, the hospital model is a superfluous reminder of his [or her] own disabilities (Goldenberg, 1979, p. 26).

One of the world's most respected computer educators, Dr. Seymour Papert, a former professor of education and professor of mathematics in the Department of Artificial Intelligence (DAI) at the Massachusetts Institute of Technology (MIT), stated the following concerning drill-and-practice, a common application of microcomputers as "tutor":

> When computers are used to cure the immediate symptoms of poor scores in arithmetic, they reinforce habits of dissociated learning. And these habits which extend into many areas of life are a much more serious problem than weakness in arithmetic. The cure may be worse than the disease (Chandler, 1983, p.83).

Fortunately, a second type of computer application in education developed quite rapidly; it is called "eyeglasses" by Goldenberg and "student-centred" by Goodyear and Barnard. In this model, the focus is taken off the computer and placed on the student. It is the student who programs the computer, at his or her own pace, and in the ways he or she desires. Using this type of application, physically and communcatively handicapped children have been able to draw, make music, write letters, improve academic skills, and

perform countless other tasks that were previously impossible.

Among those on the vanguard of research in this area is Dr. Seymour Papert, quoted above. It was Dr. Papert and his team of computer scientists who developed a computer language called Logo which, while was powerful as many other high-level programming languages, was readily comprehensible by students of all ages (Watt, 1982, p. 116). The "Logo microworld" (Lawler, 1982, p. 140) stresses not only problem-solving, but also the development of a problem-solving method (Weir, Russell, & Valente, 1982, p. 342). Using simple commands such as FORWARD, BACK, LEFT, RIGHT, etc., the student directs the actions of a small triangle, called a "turtle," around the screen. The turtle leaves a trail behind itself, enabling the student to draw pictures of varying complexity. The importance of this type of activity for handicapped students lies in the fact that they are actually causing movement, affecting the environment around them (the "Logo microworld" in this case). For many handicapped students, this is a new experience, and one that is vital to successful education. Throughout the history of education and psychology, prominent pedagogues such as Bruner, Kephart, Piaget and Papert, have hypothesized that "cognitive development depends on activity" (Goldenberg, 1979, pp. 39-41). These hypotheses were discussed extensively in the section of this study entitled **The Role**

of Motor Learning in the Development of Cognition. It is precisely these integral types of motor activity that the microcomputer can facilitate for the handicapped student, especially the multiply-handicapped student.

It is at this point that Goldenberg's second application of microcomputer technology in education ("eyeglasses") melds with the third application, "mirror." By mirror, Goldenberg means "feedback," or the immediate effects caused by the subject's actions. For many physically handicapped children, even the slightest movement of a limb requires extraordinary exertion. After having expended all that energy, the results are often not very encouraging. However, using Logo or a similar application of microcomputer technology, the exertion causes a tangible effect--the turtle moves! It is precisely this feedback that is very often necessary to motivate a student to continued effort.

Daniel Chandler's British Classification

Daniel Chandler's book, **Micro Primer Study Text**, is one component of a multi-media learning pack for teachers and students in the United Kingdom. This learning pack is part of the Micros in Primary Schools Scheme, commissioned under the Microelectronics Education Programme (MEP) and administered through the Council for Educational Technology (CET). The Micros in Primary Schools Scheme, the MEP, and

the CET are described in detail in the section of this study entitled **Governmental Organizations.**

Chandler divides educational computing into three categories called "models of learning," which he stresses overlap at points: computer-managed learning (CML), computer-assisted instruction (CAI), and computer-assisted learning (CAL) (See Figures 3 and 4 in Appendix C). He also notes that all three of these approaches are sometimes misnamed CAL or generalized and called CBL (for computer-based learning) (Chandler, 1983, pp. 69-70).

Chandler's first category, CML (see Figure 5 in Appendix C), does not wholly correspond to any of the categories proposed by Goldenberg. In CML, the computer assists the teacher with the handling of assessment tests, record-keeping, and often remedial guidance for the student. "The purpose of CML is to release teachers from routine tasks to allow them to concentrate on the teaching that they do far better than a machine" (Chandler, 1983, p. 69).

Computer-assisted instruction (CAI) (see Figure 6 in Appendix C) is, for Chandler, practically synonymous with Goldenberg's category "tutor." According to Chandler, CAI has its roots in programmed learning and teaching machines. "Based on the behaviourist model of learning, the aim is to transmit information to the learner. The focus . . . is on the <u>subject-matter</u>" (author's italics, Chandler, 1983, p. 69).

The need for a method of educational computing which focused more on the student was felt in the United Kingdom, just as it was felt in the United States. In CAL (see Figure 7 in Appendix C), "learning is more by discovery than by passive assimilation." Chandler even uses the example of Logo as a means of illustrating the creation of a framework within which possibilities can be explored by the student (Chandler, 1983, p. 70).

Early Microcomputer Applications in Special Education

Realizing the vast implications of an educational method which combines the best aspects of the models of learning discussed above, special education researchers began to experiment with the computer's therapeutic effects for handicapped students. Much of the early research and development in this field occurred at the University of Edinburgh (Watt, 1982, pp. 117-120), with several American pilot programs conducted at the Cotting School for Handicapped Children in Boston, Massachusetts (Cotting School, 1983, passim); the League School for Autistic Children in Newton, Massachusetts; and the Carroll School in Lincoln, Massachusetts (Weir, Russell & Valente, 1982, p. 347). It was through the development of several types of hardware interfaces that the handicapped were able to access the computer (Vanderheiden, 1982, p. 136). These interfaces are discussed at greater length in the section of this study

entitled **Alternative Input Devices and Switch Controls.**

It should also be noted that microcomputers are being implemented as communications aids, in addition to their applications as educational aids. Many of the problems outlined in the section of this study entitled **Severely Physically and Communicatively Handicapped Students** can be ameliorated through the use of microcomputer based aids. These applications are discussed in the section of this study entited **Computers as Communicators.**

The Dissemination Network

Realizing the vast potential of microcomputer technology in the education of handicapped students, policy makers, computer programmers and technicians, and special education teachers and administrators began to form networks to disseminate the knowledge of evolving technologies. The organizations which comprise these networks fall into three general categories: governmental organizations, schools (state and private), and other organizations. In this section of the study, many descriptions are taken verbatim from information sheets and promotional literature distributed by the organizations themselves.

Governments. Organizations

The single largest governmental organization in Great Britain for the dissemination of educational microcomputer technology is the Microelecronics Education Programme (MEP). The MEP was initiated in 1981 and is currently due to end in March, 1986. It is financed by the Department of Education and Science in England, Northern Ireland, and Wales, and administered by the Council for Educational Technology.

The aim of the Programme is to help school to prepare children for life in a society in which devices and system

based on microelectronics are commonplace and pervasive. In addition, the Programme aims to help teachers to use the technology to encourage learning in the children they teach.

The MEP's activities are two thirds regional, one third national. To implement the regional aspects of the Programme, the 109 Local Education Authorities (LEA's) of England, Northern Ireland, and Wales have grouped themselves into 14 regions. Each of these is served by an MEP Regional Information Centre (RIC) who offer a materials viewing, advice, and general teacher support service. The RIC's are linked electronically to form a network. See Figure 8 in Appendix C for a map designating RIC locations.

There are 4 Special Education Microelectronics Resource Centres (SEMERC's) which are linked to the 14 RIC's. The SEMERC's are located in Bristol, Manchester, Newcastle, and Redbridge (London). See Figure 9 in Appendix C for a map designating SEMERC locations. Three of the main functions of the SEMERC's are information, teacher training, and curriculum development:

i) Information: SEMERC's are primarily an information and advice resource. They have a wide range of software and hardware that teachers can use and sometimes borrow. However, as well as acting as an information clearing house, the SEMERC's are actively helping to build up knowledge about how the micro can be used most effectively in the special school curriculum. This is done by encouraging questioning and discussion of its educational contribution,

by enabling practitioners to exchange experiences and by supporting software evaluation. By acting as a focus point for developments, the SEMERC's encourage contacts and links that will push forward the use of the new technology. This includes bringing together researchers and teachers so that the right questions are asked, putting developers in touch with manufacturers and enabling teachers with common interests to meet.

ii) Teacher Training: One of the main activities of the SEMERC's is taking part in and supporting training courses. As each SEMERC covers a quarter of England, Northern Ireland, and Wales, it is unrealistic to expect more than a small proportion of the courses to be based at the SEMERC. They are therefore a mobile resource (with an annual mileage of approximately 18,000). The teacher training activities have largely been at the awareness level; however, as new devices, software and approaches are developed, the need for such courses continues at an increasing rate.

iii) Curriculum Development: The SEMERC's play an important role both in stimulating discussion and debate about "good practice" in the classroom and also in getting good curriculum ideas converted into useable software. The MEP has funds for the production of software, and increasingly the SEMERC's are becoming involved in helping teachers formulate curriculum development proposals. This

aspect of MEP's work is crucial, as the success of any computer-aided curriculum depends stongly on available software.

The MEP has encouraged materials for all ages and abilities to be researched and developed by a variety of agencies. The MEP has been responsible for creating training packs which accompanied the equipment subsidised by the Department of Trade and Industry's (DTI's) scheme for schools. This scheme allows schools to purchase half-price computers. Jim Sandhu notes:

> Of the 7000 odd secondary schools only 600 have not take up the Department of Trade and Industry's offer of half-price computers. Amongst primary schools, about 14,000 have taken up the same offer (Sandhu, 1983, p. 62).

Although no comparable figures were available specifically for special education schools, it is important to realize that technology usually begins in school for the non-handicapped and then percolates downward to the handicapped.

In the United States, it was estimated that elementary and high schools bought $488 million worth of microcomputer equipment in 1983. Hardware purchases accounted for $450 million, while only $38 million was spent on software. Schools bought 180,000 microcomputers in 1983, bringing the cumulative total to 400,000 micros in American schools. It has been estimated that this figure could grow to nearly two million by the end of 1987. More than two-thirds of all

American schools have at least one desktop computer (InfoWorld, 20 February 1984, p. 22).

Besides providing classrooms with computers under government programs, it is very important that appropriate teacher training be provided. The Department of Education and Science (DES) set aside £21 million (approximately $30 million at the time the estimate was made) to provide for software development and teacher training through the MEP. In 1983, Jim Sandhu reported that the MEP had sent some 15,000 teachers and related professionals to short computer awareness courses. It had also developed a library of 400 pieces of educational software for the SEMERC's (Sandhu, 1983, p. 62).

The MEP has National Coordinators to provide educational direction to the In-Service courses and to keep the regional training staff abreast of the latest technological developments.

Through training and general information dissemination, the Programme is helping to increase social awareness of new technology as rapidly as possible.

A very important network specificaly for the communicatively handicapped has been developed in Great Britain. The Department of Health and Social Security (DHSS) and Welsh Office, in association with the Royal Association for Disability and Rehabilitation (RADAR), have established a network of Communication Aids Centres (CAC's)

throughout England and Wales. The first CAC was started at Frenchay Hospital, Bristol; there are currently five other CAC's in Britain.

The aim of the Centres is to help find solutions to the problems of the speech impaired and to develop and spread good practice. The Centres are staffed by speech therapists and have on display a range of communciation aids--both computerized and non-computerized--and an information bank. They are open to other therapists to enable them to learn about the aids in question, either informally, or through courses organised by the Centres. Patients can also be referred to the Centres for assessment and, where appropriate, for provision of an aid to take home. Detailed information about the acquisition of aids for the speech impaired are presented in the section of this study entitled **Computers as Communictors.** It is also anticipated that the CAC's will fulfill a valuable purpose in developing skills in evaluating the different aids on the market and formulating judgments on their suitablity for different patient groups.

It certainly seems that British educational policy makers have realized, to a large extent, the plight of severely physically and communicatively handicapped students. The development of programs such as the MEP, the SEMERC's and the CAC's bespeak some desire to allow disabled children to benefit from microcomputer based technology.

State and Private Schools

As was mentioned above, in the section entitled **Governmental Organizations**, microcomputers are beginning to permeate both British and American classrooms. This study is summarizing the developments in many, many individual special schools, both state and private. Because it will be impossible to fully describe each program, a case study of the Inner London Education Authority (ILEA) Resource Centre for Motor and Associated Communication Handicaps at Charlton Park School, London, will be presented. The Charlton Park Centre was chosen for several reasons: it is one of the oldest programs in England; it is one of the largest programs in London; and the majority of its students are both physically and communicatively handicapped.

From the following description, taken in large part from an information sheet distributed by the Centre, it should be possible to gain the salient facts common to most school-based programs. The reader is directed to **Appendix B -- Researchers and Organizations** for a useful list of the names and addresses of many other schools at which microcomputers and microcomputer based aids are integral parts of the overall curriculum.

The Resource Centre was set up by ILEA in 1968, initially to serve the Authority's schools for physically handicapped children. Its purpose is to help ILEA teachers

who have in their classes children whose educational progress is being hindered by their physical inability to communicate effectively, either in speech or writing. They provide advisory service for staff seeking information regarding communication aids, equipment, and associated teaching methods. Most of the children with whom they are concerned attend ILEA special schools, but from time to time, advice is sought from the Centre by teachers in mainstream schools on behalf of children with writing problems. Where there is need (and so far as it is possible within the limits of the Centre's small budget), suitable equipment is provided on long loan from the Centre for any child in an ILEA school who has a communication problem arising from a motor handicap.

The Centre is based at Charlton Park School, the largest of the eight schools for physically handicapped children maintained by ILEA. Charlton Park is the only ILEA school which has provision for both day pupils and weekly boarders. Possibly for this reason, there are more very severely handicapped children at Charlton Park than anywhere else in London. There are, however, a number of students with severe communication problems at the other ILEA schools for physically handicapped children, and teachers and technicians have been appointed, some full-time and some part-time, to give these children specialised help, usually by means of individual tuition (i.e., individualized tutoring).

ILEA staff are free to visit the Centre to see and use the equipment, to discuss its effectiveness in overcoming or alleviating specific problems, and to consider ways of adapting normal teaching methods, either to enable a child to become more proficient in "writing" on a typewriter or a microcomputer based aid, or, in the case of a non-talking child, to help him or her to achieve a means of communication.

Although the above description outlines the services offered by only one school-affiliated resource centre--the ILEA Resource Centre at the Charlton Park School--this information should be seen as indicative of the services offered by other similar centers throughout England.

Other Organizations

In both England and the United States, many special interest groups have formed to aid the physically and communicatively handicapped. These groups vary widely in purpose, organization, funding, and membership. They range from parents' groups to research units to international academic organizations. In this section of the study, as in the section entitled **State and Private Schools**, it will be impossible to list and describe each special interest group. Rather, the reader is referred again to **Appendix B** --

Researchers and Organizations for a detailed listing of names and addresses encompassing such groups.

Here, three organizations will be presented and described: Handicapped Persons Research Unit (HPRU) at Newcastle upon Tyne Polytechnic; International Society for Augmentative and Alternative Communication (ISAAC); and ACTIVE, a part of the Toy Libraries Association. It should be noted that not all special interest groups deal solely with microcomputer based aids; the above groups, however, do deal at least in part with disseminating such technology.

The Handicapped Persons Research Unit (HPRU) was initially set up in 1977 by Professor Laing Barden, the present Director of Newcastle upon Tyne Polytechnic. This was mainly as a result of projects carried out in the community and special schools by staff and students of the Polytechnic.

In July 1979, Jim Sandhu took over as Head of HPRU and shortly after his appointment moved the Unit to its present location on the Polytechnic's Coach Lane Campus. It is equipped with all the usual office, drawing office, motion analysis, light workshop, word processing, and computer facilities. Access is also available to the very extensive workshops, laboratories, testing, and consulting facilities of the Polytechnic's thirty-four schools.

The Unit carries out interdisciplinary research and consultancy on topics ranging from Assessment, Transport,

Access, Microelectronics, Ergonomics, Aids, Data Bases, Disability Rights, Sheltered Workshops to Playgrounds. It also organises regular exhibitions and occasional specialist seminars. Every project undertaken is externally funded.

Aside from its academic role, the Unit maintains a link with the community and is closely involved with other research establishments, special schools, hospitals, charities, and statutory organisations. At present, it is actively concerned with encouraging small firms in North East England to manufacture some of the ideas formulated in the Unit. HPRU has raised funds from them and publicised them internationally.

In policy terms, the Unit has three concurrent but distinguishable roles--academic, professional, and social. Research is crucial to all these roles.

In its academic role, the Unit provides a living demonstration of research design and development teams at work, opportunities for practical experimentation, and data for analysis or the construction of exercises. It is concerned with the generation of new artifacts, techniques, facts and laws operating within the handicapped field. In close collaboration with other Schools of Newcastle upon Tyne Polytechnic, the Unit is involved with the supervision of post-graduate students in related fields, the advancement of scholarship in research philosophy, methods, and management.

In its professional role, the Unit provides a service to client organisations and individuals, a contribution to the development of the professions engaged in the field.

In its social role, the Unit endeavours to translate research into practice. This is done through active involvement with local charitable and statutory organisations and individuals. Conferences, lectures, reports, exhibitions, databases, directories, and other means of disseminating information are an integral part of this role.

The HPRU recently received substantial funding from the Deptartment of Industry (DoI) to set up a computerised register of non-manufactured aids and related research projects. The British Database on Research into Aids for the Disabled (BARD) will contain information on design and development work, prototypes, "one-offs," latest developments, as well as research into the use of aids, surveys, and evaluations. The database will complement information provided by other organisations whose emphases lie in manufactured and commercially available aids.

The need for such a listing of who is doing what has been indicated by the response to HPRU's first **Directory of Non-Medical Research Relating to Handicapped People**, produced in 1983. This contained outlines of research projects ranging from education to family and employment, including a large selection on design of aids. Not only did HPRU receive over six hundred project entries, but there has

been a heavy demand from non-contributors requesting a copy of the directory.

The HPRU found that the Directory enabled people working on related projects to communicate techniques and findings. This exchange is essential, particularly in the field of equipment/aid design and in light of new technologies. Whereas HPRU hopes to continue producing paper directories of current research in various subjects, they propose up-to-date information on design projects to be available from BARD.

The aim of BARD, therefore, will be to facilitate the exchange of ideas which is central to the research and development stage of producing aids for handicapped people. The HPRU sees these ideas as being equally valid whether they originate in an academic or manufacturing environment or in the home.

Each entry in BARD contains a description of the project, together will the name and address of the maker, aid function, and type of handicap. Initially, dissemination of information will be through printouts in answer to specific enquiries, although HPRU hopes for some direct access to the data base when the system becomes active.

The International Society for Augmentative and Alternative Communication (ISAAC) is a single, international

organisation dealing with non-vocal and communicatively handicapped people. ISAAC was established in March 1983 for the speech handicapped, parents, teachers, professionals, and anyone else who has an interest in the field.

A quarterly newsletter "Communication Outlook" brings current events and opinions from around the world. A professional journal concentrating the best research and technical information is also available. A conference is held every two years. In 1984, the conference was help in Boston, Massachusetts, and the 1986 venue has provisionally been set for Cardiff, UK.

ISAAC answers the basic question "Who speaks for the non-vocal?" The sensible policy of involving both vocal and non-vocal, professional and non-professional, students and educators, and all interested persons results in expanding the base of people who speak for the non-vocal.

ACTIVE is an organization which encourages the development of play, leisure, and communication aids for disabled children and adults. Its aim is to help disabled people to lead more independent and active lives. The membership comprises disabled people, their relatives, those with a professional responsibility for disabled people, designers, engineers, do-it-yourself enthusiasts and those who are interested in the well-being of disabled people. All these people contribute their skills, knowledge or enthusiasm to further ACTIVE's aim.

ACTIVE was founded by Roger Jefcoate in 1975. As a consultant assessor and lecturer on technical aids for disabled people, he was visiting special schools to advise on equipment for severely disabled children and perceived that many of them could benefit enourmously from simple do-it-yourself modification of toys. As a grass roots movement, ACTIVE responded to the real needs of people and for this reason widened its focus to include disabled adults as well as children, communication and education aids as well as play aids.

Recognising the limitations and frustrations of voluntary action when there is so much useful work to be done, ACTIVE became in January 1981 part of the Toy Libraries Association, a registered charity. This gave ACTIVE an established base of provide continuity of administration and a legally constituted body to receive and administer charitable funds on ACTIVE's behalf.

Each ACTIVE meeting is different, but a lot of time is usually spent talking about new developments in technology--both high technology (electronic aids, communicators, microcomputers, etc.) and, equally importantly, low technology. Often ACTIVE members are able to see and comment on prototype equipment long before it reaches a commercial market. Sometime such designs, whilst not commercially relevant, are of general interest to ACTIVE members.

It is through the efforts of the organizations listed above, as well as many, many others, that microcomputer technology is disseminated. The interrelationship between governmental organizations, academic institutions, and many other types of organizations is crucial and leads to more efficient dissemination of these new technologies. Specificic innovations in hardware and software are discussed below.

Innovations in Hardware and Software

Much attention has already been given to the special educational needs of the severely physically and communicatively handicapped, the uses of microcomputers in education and specifically in special education, and the dissemination network for special microelectronic technology. This section of the study deals with specific innovations in hardware and software and how they can benefit the physically and communicatively handicapped.

Alternative Input Devices and Switch Controls

The most important question for the teacher of the physicallly and communicatively handicapped student is: How can this student, who may not be able to manipulate a regular keyboard, best access the microcomputer? It is

certainly possible that many handicapped students are capable of using regular keyboards. The majority of students in this study, however, were unable to do so and required more creative and extensive devices. Much to the benefit of the handicapped, several types of interfaces have been developed by computer technicians and programmers. For the severely physically handicapped, finding an appropriate single-action switch is the most important consideration. There are currently several types of switches available: pedal switches, suck/blow switches, mercury switches (which respond to body or limb position), eye switches (which respond to controlled blinking), voice activated switches, and many others. In assessing a student for a switch, it is important to discover his or her most reliable action, whether it requires gross or fine motor skill.

One very interesting development in the area of single-switch controls is the Micro-Active Toy Control Interface, developed at the Manchester SEMERC and funded through the MEP. The Toy Control interface is intended to give the teacher of profoundly mentally handicapped or young physically disabled children the possibility of extending the educational value of switch and toy systems. In this type of system, correct use of the switch system results in rewards of the activation of mechanized toys. It can also have a role in providing physiotherapy and speech therapy

tasks for older and more able users and recording performance. While simple switch and toy systems can provide a purposeful and stimulating activity, the pupil's success in using the system is likely to result in boredom or in prolonged holding-on of the switch.

The Toy Control Interface may be seen as a training aid towards use of a communication or environmental control device. With this in mind, SEMERC has a list of single-switch-controlled games and activities on the BBC microcomputer to extend this function further.

Another interesting development in single switch controls is the MICRO MIKE, a modified CB microphone which may be plugged directly into the analogue input on the back of the BBC Model B microcomputer. This gives simple voice volume control over a variety of games and activities aimed at helping the speech-impaired child. The Manchester SEMERC is also developing a program to link the MICRO MIKE voice control system to the Toy Control Interface to provide toy play as a reward for vocalization while recording performance.

After the student becomes adept at controlling a single switch, it is often possible, depending of the severity of the physical and/or mental handicap, to proceed to more complex switch systems. Usually the same type of switch system is utilized. The single switch may be replace with two switches, with four switches, or even with one of several types of alternative keyboards.

The most common type of alternative keyboard in England is the Star Microterminals Concept Keyboard. These keyboards consist of flat, durable, and washable surfaces connected to the microcomputer by a thin ribbon cable. Currently, the Concept keyboard comes in two sizes, A4 and A3 (approximately 8-1/2" x 11" and 11" x 14") and can be configured to operate on a variety of microcomputers.

As the student is weaned from a single, double, or quadruple switch system, the Concept keyboard allows the teacher to divide the keyboard surface into quadrants for input. In the beginning, the entire keyboard surface may be designated as one switch, corresponding to single switch input. Graudually, the keyboard can be divided into more and more quadrants as the student's fine motor control develops. Overlays on the keyboard allow the sections of the keyboard to assume visual significance for the student. So, in much the same way as the student progresses from one to many physical switches, he or she can progress from one to many quadrants on the Concept keyboard.

One other important consideration in designing switch system for the handicapped is physiotherapeutic. Although the student's most reliable movement should be targetted for the switch device, it is also possible to attach switches to the hands, arms, feet, legs, or head with the purpose of developing better gross or fine motor control in the limb or limbs chosen.

Through the development of improved switch interfaces, including the incorporation of voice controlled input systems, even the most severely physically and/or mentally and/or communicatively handicapped students can use microcomputer based aids as therapeutic devices. Further information concerning switches and interfaces, including any of the devices described above, may be obtained from the SEMERC's.

Educational Programs and Software Development

Once an acceptable method of input has been determined, perhaps using the switch systems described above, the choice of software must be made. Currently, the variety of available software ranges from simple programs for the Micro Active Toy Control Interface to more complex word processing packages like MAC-Apple, described below. It should be noted that many other programs, sold for non-handicapped users, can be turned into single- or multiple-switch programs with relative ease.

Two programs are supplied with the Toy Control Interface, described above: TOYREP, which allows the teacher to demand any number of switch operations to produce a timed response from a battery operated toy; and TOYHOLD, which allows the teacher to demand prolonged switch operations to produce a timed response from a battery operated toy. The Unit and its introductory software allow

a great variety of demands to be made upon the pupil's use of the switch system, and at the same time present a record of performance. These demands may be varied very easily and quickly in steps that can be imperceptible to the pupil.

In connection with the MICRO MIKE device, also described above, some available activities include: 1) CITY draw a city skyline with your voice. Height, width, and placement of buildings are dependent on volume, duration, and timing of vocalisation; 2) SHOOT -- use carefully timed vocalisations to play a shooting gallery game; 3) BOAT -- steer a speedboat through the channel, past some rocks, using your voice; and 4) COPTER -- vocalisation apparently powers the rotors of the helicopter causing it to rise, pressing the MICRO MIKE switch causes forward motion. By the combination of these actions, you must try to rescue a man from his canoe by hovering the helicopter close over the canoe.

Although the exact content of these programs is immaterial, it is important to understand the incorporation of general concepts involved in vocalization: volume, duration, and timing.

After the development of the basic skill described above, it is possible to incorporate increased academic orientation to the microcomputer experience. The most beneficial types of programs, it has been determined in

England, are referred to as "content-free" programs. These programs allow the teacher to program (with little or no computer knowledge) daily lessons, using whatever curriculum material he or she desires. Two examples of this type of program are presented below; these programs are currently in use at the Ormerod School. The choice of programs presented is not meant to advocate any one program over another, but rather to give the reader an understanding of the types of "content-free" programs that are available.

SENTENCE-SCAN -- enables the teacher to enter up to twenty lists of words which are then displayed in large letters when selected by the pupil using a single/double switch or keyboard to build up sentences. The teacher can also enter words for immediate use. Words and sentences can be printed or spoken through a speech synthesizer if desired.

WRITE -- the teacher can enter up to twenty words or sentences which are then displayed in large letters word by word for the pupil. Each word is presented to the pupil for copying at the top of the screen, and is then built up into a sentence at the bottom. The completed sentence can then be printed or spoken through a speech synthesizer if desired.

Other programs, such as Matchword, Wordscan, Pointerboard, and Numbertrack are in use at the ILEA Resource Centre at the Charlton Park School.

A final type of software that is currently available for the handicapped student is the MAC-Apple program, developed by Patrick Poon, currently at the Ormerod School. The MAC-apple program for the Apple II microcomputer offers severely physically handicapped children, even those unable to walk, talk, write, feed or toilet themselves, the possibility of writing, drawing, and "talking" by means of switches or keyboard (expanded, mini, or standard).

The benefits of the MAC-Apple program are great, as it allows the pupil to: 1) use standard word processing facilities, such as correction of typing errors without assistance, automatic adjustment of line endings, etc.; 2) be provided by their teachers with an appropriate operating mode from a choice of eleven modes, and, if switch users, with a standard or personalized letter grid; 3) employ automatic shift, a facility which automatically spaces, shifts to upper case and returns to lower case, as necessary at the end of sentences; 4) display and work simple arithmatic calculations more easily; 5) compile and access individualized word stores--whole words, phrases, and sentences that can be printed on selection--offering increased speed of written output and an aid to improved reading and spelling skills; 6) draw: the ability to draw provides a powerful educational tool and a rewarding leisure time activity; and 7) "talk" by means of synthesized speech.

The programs described above, in addition to programs like the Logo language described in the section of this study entitled **E. Paul Goldenberg's American Classification**, enable the handicapped student to employ the microcomputer both as a communication aid and as an education aid. Current software development is aimed at the creation of improved content-free programs to allow the teacher to more easily incorporate the microcomputer in the existing curriculum.

Computers as Communicators

Although it has been hinted at in the above discussions, microcomputers and microcomputer based aids have definite applications for the speech impaired. Jayne Easton and Pam Enderby, in their pamphlet **The Acquisition of Aids for the Speech Impaired**, list possible sources of communication aids: a) provision of aids through the National Health Service; b) provision of aids through Local Education Authorities; c) provision of aids through the Manpower Services Commission; d) loan facilities; e) private purchase; f) charity funds; g) voluntary organisations; h) other information agencies. The value of the Communication Aid Centres, described in the section of this study entitled **Other Organizations**, cannot be overstressed.

The ILEA Resource Centre for Motor and Associated Communication Handicaps at Charlton Park School has

published guidelines which they feel are useful in the provision of microcomputer based communication aids for the speech impaired. These are listed below, in what they consider to be their order of importance:

1) the degree to which the child is motivated;

2) the provision of suitable seating and suitable positioning of equipment;

3) his or her physical ability to make a controlled movement or movements;

4) the skill of the staff in
   i) finding his or her best movement;
   ii) selecting a suitable switch or switches;
   iii) mounting the switches in a position which will, if possible, encourage the development of an economical, efficient movement in the future;

5) the ability of his or her teachers, as he or she progresses through the school, to diagnose any learning difficulties the non-speaking child may have, in addition to his or her physical problems, and to plan suitable teaching programs for him or her;

6) the child's level of educational attainment;

7) the extent to which the aid he or she is using meets his or her specific needs;

8) the availability of experienced staff to monitor his or her physical operation of the equipment, as he or she grows and as new aids are developed, and to effect any changes necessary to ensure optimum achievement throughout his or her school life.

After all of these factors have been considered, the child may be provided with the most acceptable speech aid. Ease of input and output are major considerations in selecting communication aids for the speech impaired. With

the wide variety of aids which are available today, it is possible in most cases to normalize the child's experience of an easy and fluent communication system, rather than force him or her to use vocalization if this is not the most developed skill.

CONCLUSION

After synthesizing all of the information that has been presented above, the following four specific problems in the use of microcomputer technology by physically and communicatively handicapped children can be delineated: lack of programmers/educators; lack of networking among professionals; lack of sufficient funding; and lack of quality hardware/software. By concentrating on these problems, the intent is not to downplay or belittle the great projects currently being undertaken by policy makers, special educators and administrators, and computer programmers and technicians. Rather, it is to encourage the continuation of such efforts.

The overriding problem in applying microcomputer technology in the special education classroom is the dichotomoy in knowledge between the special educator and the computer technician: the educator knows what he or she wants done, but does not know how to make the computer do it; the technician knows exactly what the computer can do, but does not know what is in the student's best interest. Often in the past, these people could not even communicate their needs to one another because of the jargon present in both fields. Today, through computer courses for educators and education courses for technicians, this dichotomy is narrowing. In the future, continued interdisciplinary

education should enable special educators to make more informed decisions regarding the technology apprised by their students.

Although organizations like ISAAC, ACTIVE, the SEMERC's and the CAC's, have been developed, there is still a palpable need for greater networking between professionals involved in high technology special education. The implementation of BARD should help in this area, as should improved videotext systems. Intranational and international exchanging of ideas and implementations is vital to the development of suitable microcomputer technology.

A problem which is not unique to microcomputer technology and special education is the problem of funding. Because the handicapped represents only a small fraction of the entire population, and because the severely physically and communicatively handicapped represent an even smaller fraction of the entire population, it is difficult to obtain funding for sorely needed projects. It is hoped that with continue funding from the British government, an organization like the MEP can continue to function. The continuance of the SEMERC's and CAC's is also vital and can only be ensured through renewed financial support.

The final problem listed above--the shortage of quality hardware/software for the physically and communicatively handicapped--is becoming less and less of a problems as time goes on. Each day brings new developments in this field, which is actually on the vanguard of modern technology.

With the amelioration of the three problems listed above, the scarcity of high quality equipment should end.

The field of microcomputer based aids for the physically and communicatively handicapped is a revolutionary field in modern technology. It is a field in which new developments arise daily. This study has shown many of the ways in which microcomputers are currently being used. How will the handicapped use microcomputers tomorrow? Who knows! The range of applications is limited only by the creativity of the implementors and the handicapped themselves.

APPENDIX A

GLOSSARY OF SPECIALIZED TERMS

ACAC -- see Assistive Communication Aids Centre

artificial intelligence -- the capability of a machine to imitate intelligent human behavior (as reasoning, learning, or the understanding of speech).

Assistive Communication Aids Centre -- the first Communication Aids Centre, established at Frenchay Hospital, Bristol.

ataxia -- an inability to coordinate voluntary muscular movements that is symptomatic of some nervous disorders, including cerebral palsy.

athetosis -- a nervous disorder, seen chiefly in children, that is marked by continual slow movement, especially of the extremities and is usually due to a brain lesion.

bilateral hemiplegia -- paralysis of the upper portion of one lateral half of the body and of the lower portion of the other lateral half, resulting from injury to the motor centers of the brain.

CAC -- see Communication Aids Centre

CAI -- see computer-assisted instruction

CAL -- see computer-aided learning

CET -- Council for Educational Technology

CML -- see computer-managed learning

CP -- see cerebral palsy

cerebral palsy -- any one of a group of disorders affecting control of the motor system and due to brain damage caused by various prenatal, perinatal, and/or postnatal factors.

Communication Aids Centre -- five centres (at Charing Cross Hospital, London; the Wolfson Centre in Mecklenburgh Square, London; the Health Centre, Sandwell District; Royal Victoria Infirmary, Newcastle District; and Rookwood Hospital, Cardiff) established by the DHSS and RADAR to aid the speech impaired.

computer-aided learning -- education using a microcomputer where learning is more by discovery than by passive assimilation.
computer-assisted instruction -- has its roots in programmed learning and teaching machines. The focus of this approach is the subject matter.

computer-managed learning -- computer assistance with the handling of assessment tests, record keeping, and often also the remedial guidance of the learner.

DES -- Department of Education and Science

DHSS -- Department of Health and Social Security

DoI -- Department of Industry

DTI -- Department of Trade and Industry

diplegia -- paralysis of corresponding parts on both sides of the body.

ESN(M) -- see educationally subnormal (moderate)

ESN(S) -- see educationally subnormal (severe)

educationally subnormal (moderate) -- a category of moderate educational disability used in the United Kingdom.

educationally subnormal (severe) -- a category of severe educational disability used in the United Kingdom.

feedback -- the return to the input of a part of the output of a computer process for self-corrective action.

HPRU -- Handicapped Persons Research Unit

hardware -- any electronic or mechanical equipment used in association with data processing.

hemiplegia -- paralysis of one lateral half of the body or part of it resulting from injury to the motor centers of the brain.

ILEA -- Inner London Education Authority

interface -- computer equipment or programs designed to communicate information from one system to another.

LEA -- Local Education Authority

Logo -- a high-level computer programming language developed at the Massachusetts Institute of Technology (MIT) under the direction of Dr. Seymour Papert. "Logo" is not an acronym; rather, it is derived from the Greek "logos," meaning "knowledge."

MEP -- Microelectronics Education Programme

MSC -- Manpower Services Commission

microcomputer -- an electronic machine capable of accepting and processing data and producing results by carrying out repetitious and highly complex mathematical operations at high speeds. In addition, a microcomputer as opposed to a computer, is relatively low in price and small in size.

microcomputer technology -- research and development in hardware and software.

microworld -- a well-defined, but limited, learning environment in which interesting things happen and in which there are important ideas to be learned (e.g., Logo microworld).

monoplegia -- paralysis of the upper or lower portion of one side of the body.

paraplegia -- paralysis of the lower half of the body with involvement of both legs.

prevalence rate -- the rate which affects the percentage of the population that is affected with a particular disease at a given time.

prosthetic -- technically, an artificial device to replace a missing part of the body. The computer is used as a prostheses to replace missing skills.

quadriplegia -- paralysis of both the upper and lower portions of both lateral halves of the body.

RIC -- Regional Information Centre

rigidity -- a classification of cerebral palsy marked by stiff and unyielding limbs.

SEMERC -- see Special Education Microelectronics Resource Centre

software -- the entire set of programs, procedures, and related documentation associated with a computer system.

spasticity -- a classification of cerebral palsy marked by paralysis with tonic spasm of the affected muscles and with increased tendon reflexes.

Special Eduction Microelectronics Resource Centre -- four centers (in Bristol, Manchester, Newcastle upon Tyne, and Redbridge [London]) established as part of the MEP.

tremor -- a classification of cerebral palsy marked by trembling or shaking of the limbs.

triplegia -- paralysis of the upper and lower portions of one lateral half of the body and of the upper or lower portion of the opposite lateral half.

turtle -- a computer-controlled robot or graphic representation of a robot that has position and heading, each of which can be changed independently of the other.

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APPENDIX C

ADDITIONAL FIGURES

ACCEPTED CHARACTISTICS OF SPECIAL NEED	MICROCOMPUTER'S CONTRIBUTION
Difficulty in making and extending associations.	Pupil control over events reduces distance between self-image and real world events.
Restricted ability to interpret abstractions.	Simulations can be constructed which visually bridges the gap between the concrete and the abstract.
Lack of intellectual curiosity.	Interactive nature of the micro experience promotes curiosity.
Inability to generalise from obersvations.	Better associations resulting from personal involvement in the learning environment enhances pupil's ability to generalise.
Short attention span.	High level of interest encourages persistence of attention.
Poor retention of ideas in short term and long term memory.	Because of increased motivation, spurred on by new confidence, pupil identifies more readily with ideas, experiences less ambiguity, and so concepts are more easily retained.
Limited ability to transfer learning.	The child's new confidence will result in his or her taking more risks in applying various different concepts to a situation, instead of not bothering after the first appears not to work.
Impoverished sensory perception.	Modified keyboards, high resolution graphics and developments in voice synthesis provide opportunities for varied sensory experience and for enhanced signals to parrticular sensory channels.

Fig. 1 Specific Benefits of the Microcomputer in Special Education (adapted from Hogg, 1984, pp. 15-16).

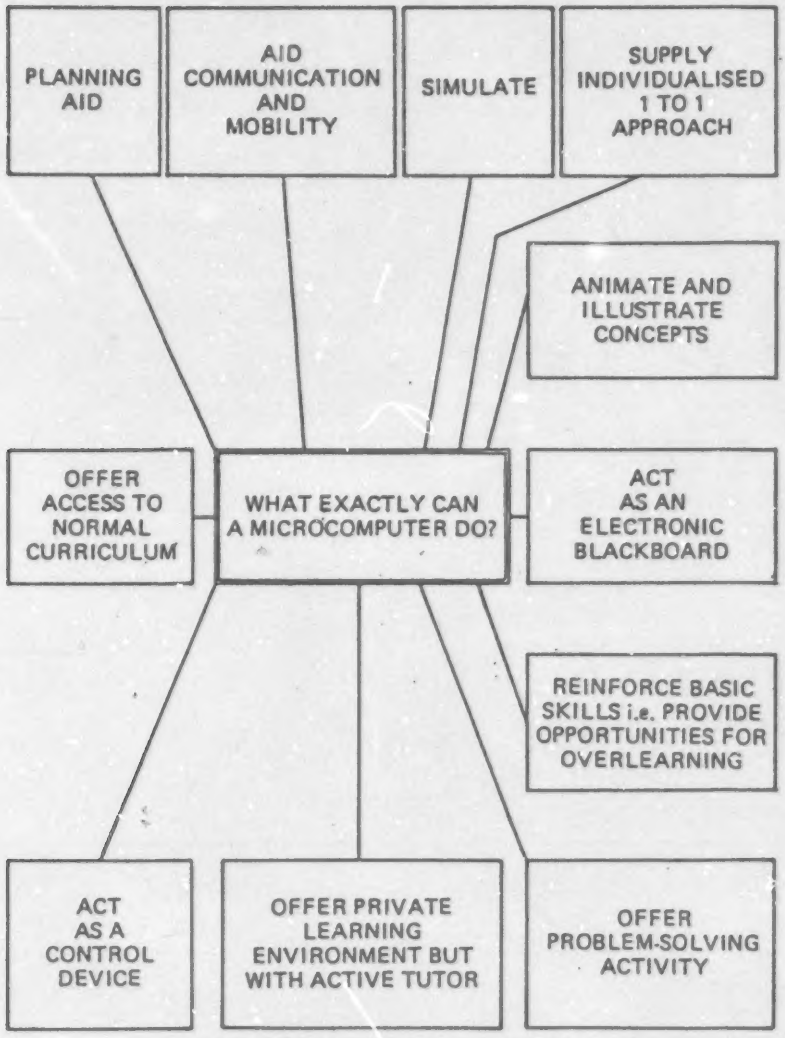

PLANNING AID
AID COMMUNICATION AND MOBILITY
SIMULATE
SUPPLY INDIVIDUALISED 1 TO 1 APPROACH
ANIMATE AND ILLUSTRATE CONCEPTS
OFFER ACCESS TO NORMAL CURRICULUM
WHAT EXACTLY CAN A MICROCOMPUTER DO?
ACT AS AN ELECTRONIC BLACKBOARD
REINFORCE BASIC SKILLS i.e. PROVIDE OPPORTUNITIES FOR OVERLEARNING
ACT AS A CONTROL DEVICE
OFFER PRIVATE LEARNING ENVIRONMENT BUT WITH ACTIVE TUTOR
OFFER PROBLEM-SOLVING ACTIVITY

Fig. 2 Some Applications of the Microcomputer to Meeting Special Educational Needs (Schools Council, 1982, Microcomputers in Special Education, p. 10 cited in Hogg, 1984, p. 40).

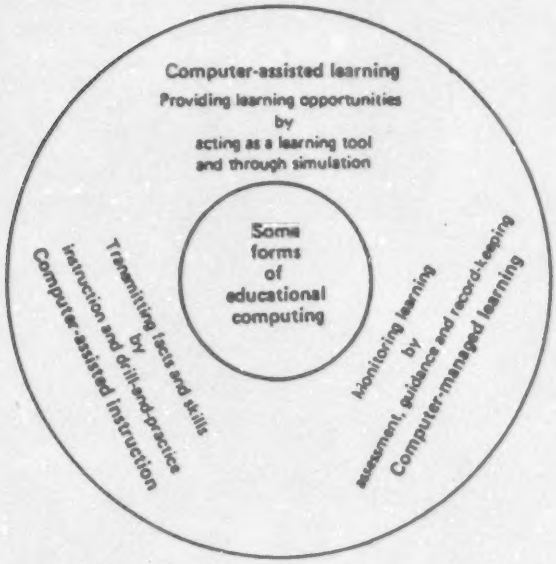
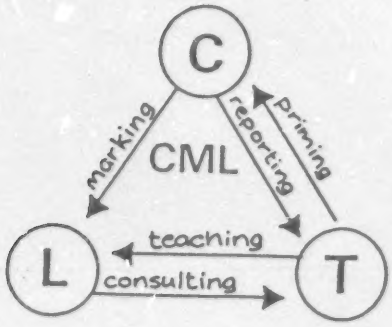
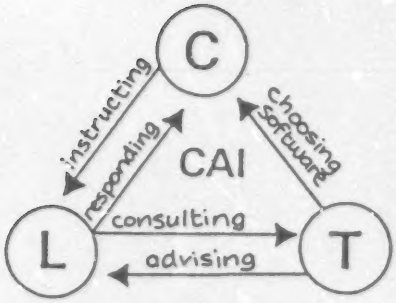


Fig. 3 Some Forms of Educational Computing (Chandler, 1983, p. 70).





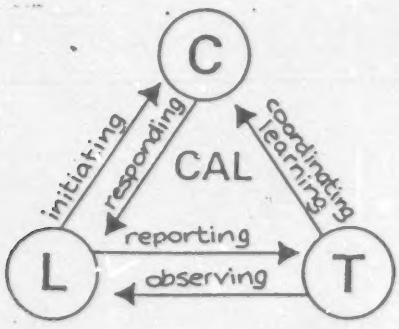


Fig. 4 Relationships Between the Computer, the Learner, and the Teacher (Chandler, 1983, p. 82).

Advantages	Disadvantages
Frees the teacher to teach.	May require more equipment -- a card reader and a printer.
More objective assessment.	Impersonal.
Allows the teacher to focus on constructive observation rather than looking for errors.	Requires highly structured tests. Creation of tests requires a lot of work if they do not exist.
Potentially faster feedback.	Has to be primed with answers and comments for each topic.
Makes more detailed assesament practicable.	Children may find cards hard to complete.
Automatic record-keeping -- easily updatable; reprintable; easier to keep parents informed.	

Fig. 5 Advantages and disadvantages of computer-managed learning (CML). (Chandler, 1983, p. 74)

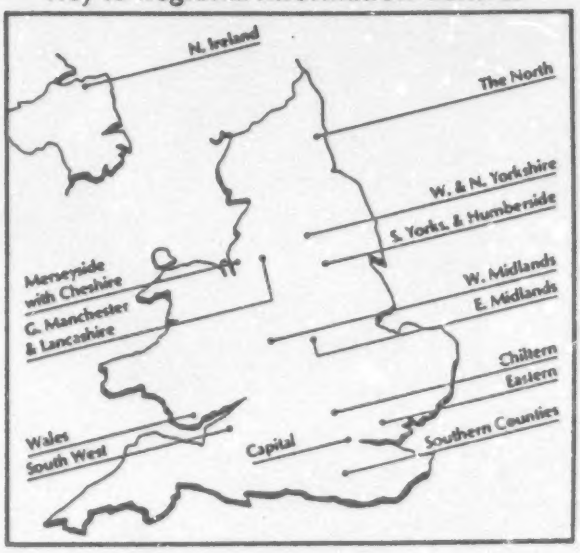
Advantages	Disadvantages
Graded, self-paced tuition.	Cannot easily be changed on spur of moment to suit circumstances.
Unlimited patience in repetitive tasks.	Individual use wasteful of what is still a scarce computer resource.
Almost self-sufficient -- allows teacher to concentrate on guidance.	Only suitable for topics which can be broken down into clear-cut stages.
Exercises can be randomly generated within parameters defined by the teacher, so it can be used again and again.	The skills taught may not be transferable outside the instructional program.

Fig. 6 Advantages and disadvantages of computer-assisted instruction (CAI). (Chandler, 1983, p. 77)

Advantages	Disadvantages
Child-centred -- encourages active participation and independent research.	May require learner who is already well motivated.
Encourages group cooperation.	Child may 'miss the point' because of lack of internal reinforcement, or because the program's cognitive structure is different from the child's.
Can make possible simulations which would otherwise be impractical because of cost, complexity time or danger.	Can take a very long time to produce a good CAL package.
More economical use of compter resource (more users).	Easy to underestimate how much time will be involved in using the program.
Bridge curriculum areas.	More work for teacher than with CAI/CML.
Allows child to concentrate on interpretation rather than assimilation.	

Fig. 7 Advantages and disadvantages of computer-assisted learning (CAL). (Chandler, 1983, p. 79)

Key to Regional Information Centres



Capital
ILEA Educational Computer Centre,
John Ruskin Street,
London SE5 0PQ
Tel: 01 735 9123 ext 216

Chiltern
Chiltern Regional Centre,
Advisory Unit for Computer Based Education, Endymion Road, Hatfield, Herts, AL10 8AU.
Tel: 070 72 65443

Eastern
Chelmer Institute of HE,
Victoria Rd. South, Chelmsford,
Essex, SM1 1LL.
Tel: 0245 356940

G. Manchester & Lancs.
Manchester Poly. Didsbury School of Education, 799 Wilmslow Road,
East Didsbury, Manchester, M20 8RR.
Tel: 061 445 0780

Merseyside with Cheshire
Liverpool Poly., 70 Mount Pleasant,
Liverpool L3 5UX.
Tel: 051 207 3581 ext 2531

E. Midlands
Towers Library, The University,
Loughborough, Leicestershire,
LE11 3TU.
Tel: 0509 37398

W. Midlands
MACE, At Four Dwellings School,
Dwellings Lane, Quinton,
Birmingham, B32 1RJ.
Tel: 021 421 6361

Northern Ireland
MEP Micronet Centre,
South Building,
New University of Ulster,
Coleraine,
Northern Ireland.
Tel: 0265 4141 ext 341

The North
Resources Centre, Newcastle Poly.,
Coach Lane Campus,
Newcastle upon Tyne, NE7 7XA.
Tel: 091 2700424

Southern Counties
Southern Region Microelectronics Information Centre, Furnace Drive,
Furnace Green, Crawley, RH10 6JB.
Tel: 0293 546216

South West
Bristol Poly., Coldharbour Lane,
Frenchay, Bristol, BS16 1QY.
Tel: 0272 656261 ext 310.

Wales
Welsh Joint Education Committee,
245 Western Avenue, Cardiff, CF5 2YX.
Tel: 0222 561231 ext 63

S. Yorks & Humberside
Educational Development Centre,
Kingfisher First School,
Coventry Grove, Doncaster DN2 4PY.
Tel: 0302 63784/63800

W. & N. Yorkshire
Queenswood House, Leeds Poly.,
Becketts Park Site, Leeds, LS6 3QS.
Tel: 0532 783437/8

Fig. 8 Regional Information Centres (RIC's) Throughout England, Northern Ireland, and Wales.

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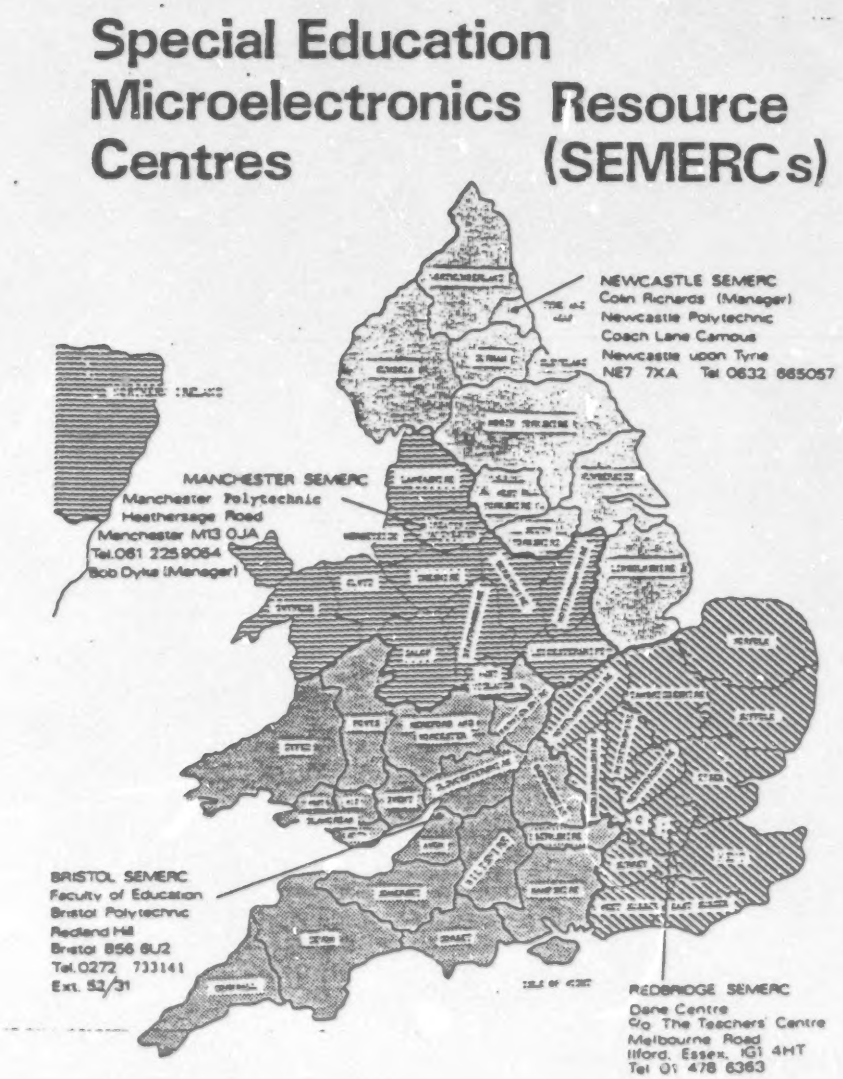

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Fig. 9 Special Education Microelectronics Resource Centres (SEMERC's) Throughout England.

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Fig. 10 The chart that follows compares the cost of educating a non-handicapped student with the cost of educating a handicapped student. All figures are in dollars per student. The categories A-I are defined below:

A	instructional supplies/texts
B	instructional equipment
C	related services/equipment
D	related services/administration
E	district level administration
F	school level administration
G	facility maintenance/operation
H	facility modification
I	debt service

COST COMPARISON

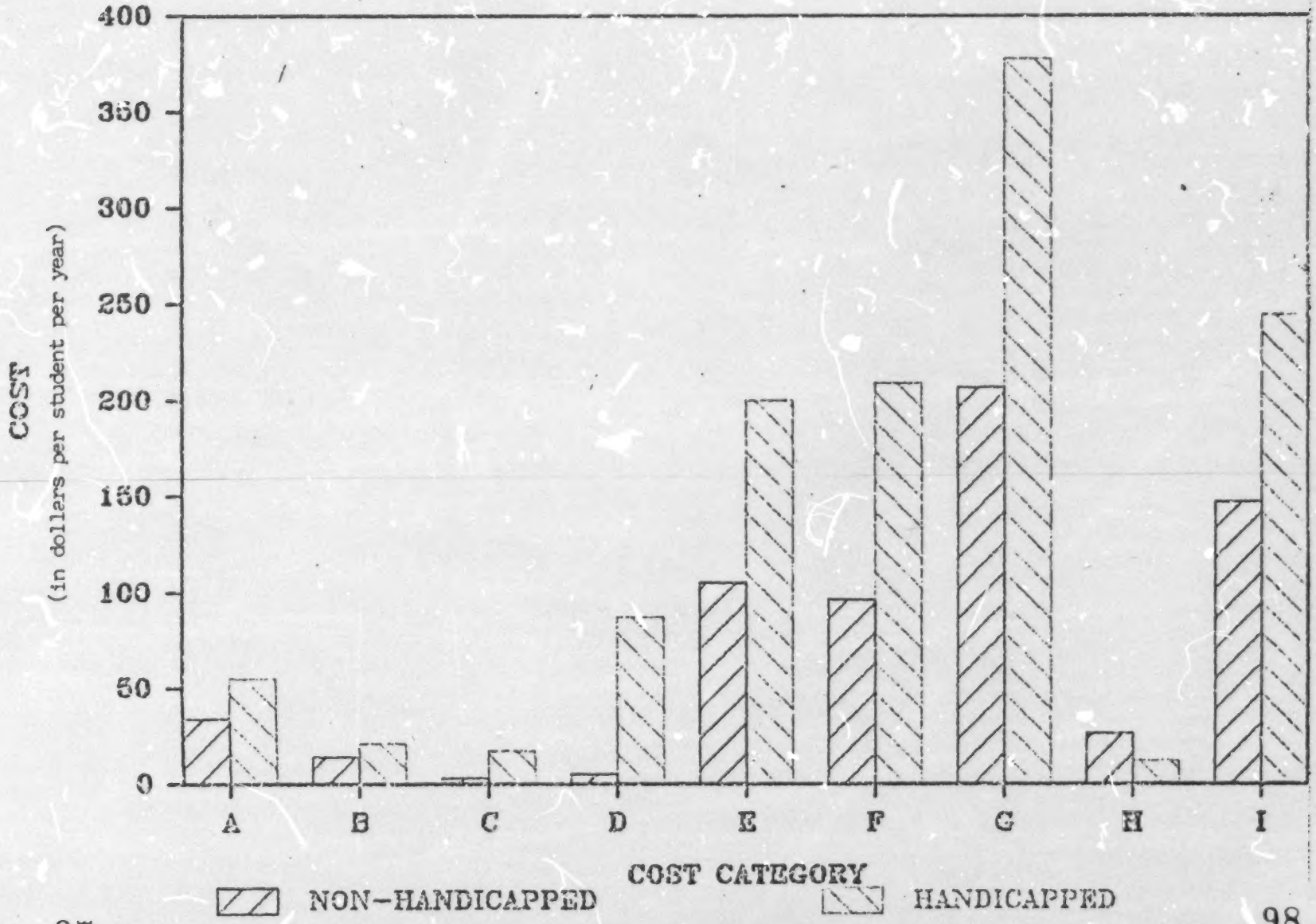
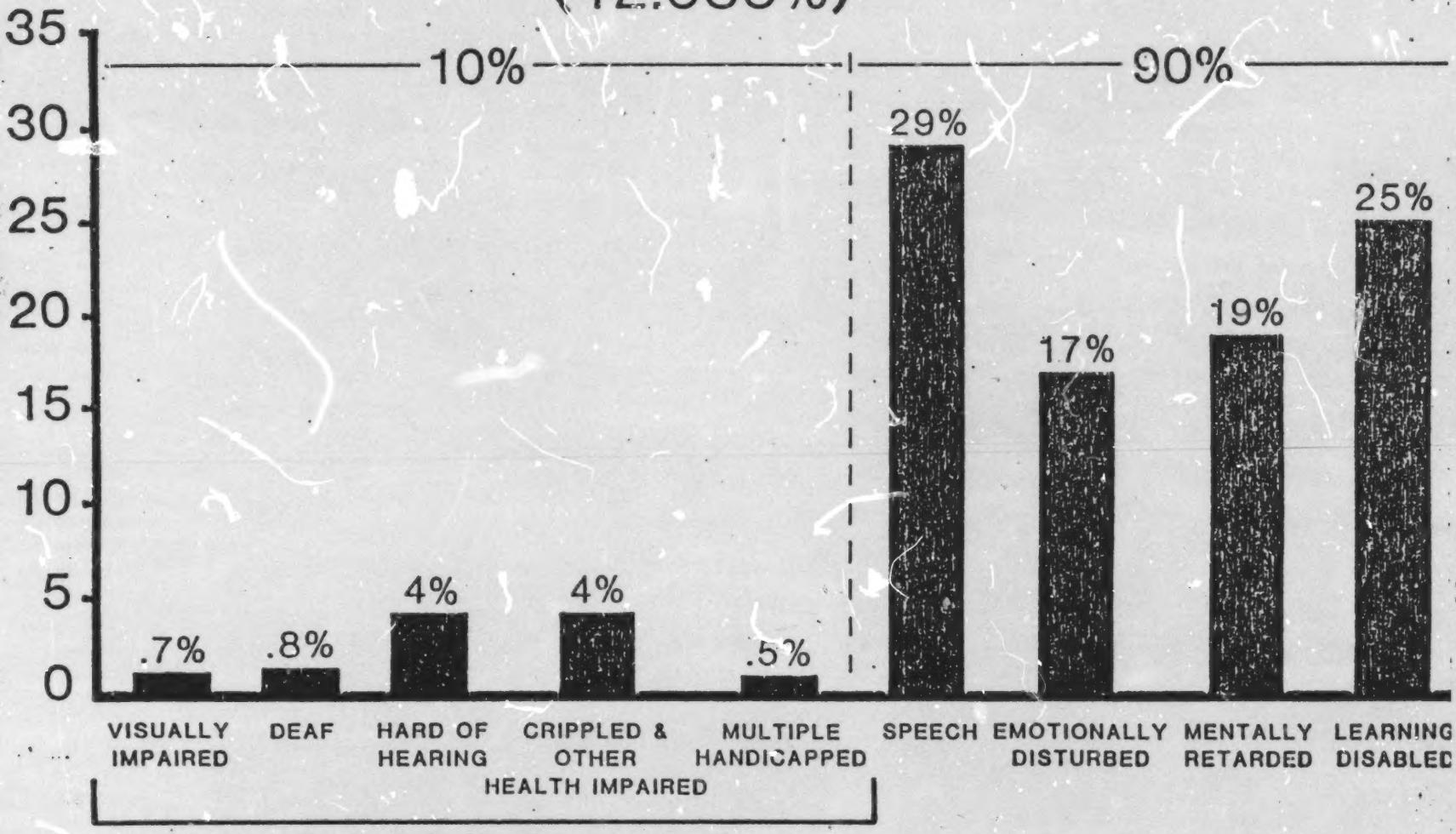


FIGURE 11:

PREVALENCE RATE OF SCHOOL-AGE HANDICAPPED (12.035%)*



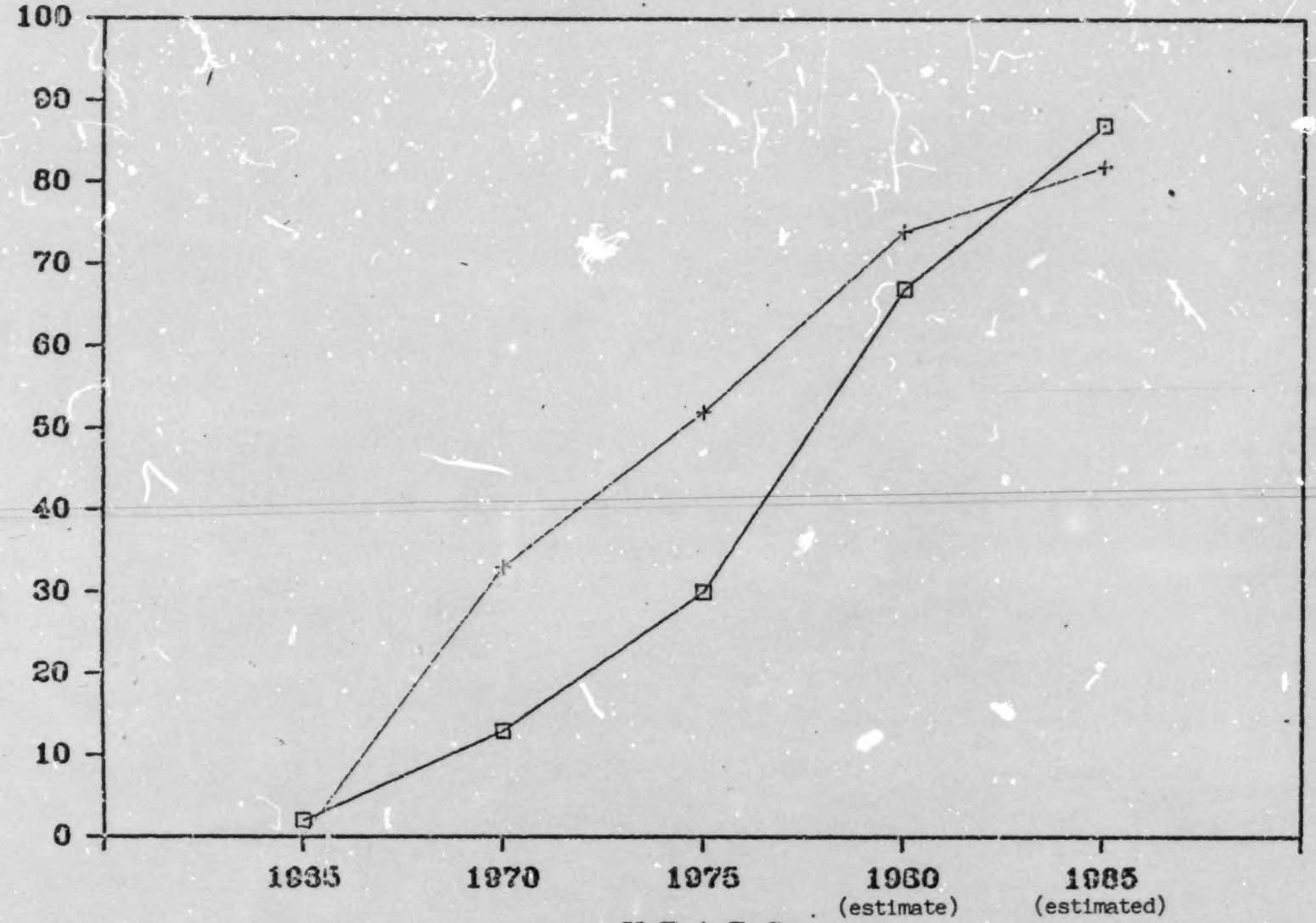
Handicapped Emphasis in OTA Report:
Technology & Handicapped People May 1982

Microelectronic Aids & Handicapped Children -88-

*Report To Congress: Unanswered Questions on Educating Handicapped Children in Local Public Schools GAO/HRD-81-43, February 5, 1981.

COMPUTER USE TRENDS

(in the United States)



LIST OF REFERENCES

Abelson, H. (1982). A beginner's guide to Logo. BYTE: The Small Systems Journal, 7(8), 88-112.

Adams, J. (1983a). A day to remember. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue). 28-29.

Adams, J. (1983b). HPRU playaids. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 45.

Adams, J. (1983c). World wide appeal. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 14-15.

Baker, B. (1982). Minspeak. BYTE, 7(9), 186-202.

Bedarida, F. (1979). A social history of England 1851-1975 (A.S. Forster, Trans.). London: Methuen.

Bennett, R. E. (1982). Applications of microcomputer technology to special education. Exceptional Children, 49, 106-113.

Brooks, K. (1983). Equal access for the handicapped--An update. American School and University, 55, 30-32.

Budoff, M. & Hutten, L. R. (1982). Microcomputers in special education: Promises and pitfalls. Exceptional Children, 49, 123-128.

Central Office of Information. (1981). Education in Britain. (pamphlet). London: Her Majesty's Stationery Office.

Chandler, D. (1983). Microprimer Microelectronics Education Programme study text: A foundation for teachers. Loughborough, Leicestershire, England: Tecmedia Ltd.

Clamp, S. (1983). Computer assisted learning and the less able. Remedial Education. 18(1), 15-18.

Cotting School for Handicapped Children. (1983). Computers at the Cotting School for handicapped children. Boston: Cotting School for Handicapped Children.

Council for Educational Technology & Microelectronics Education Programme. (nd). Microelectronics and special education. (CET/MEP information sheet).

Cruickshank, W. M. & Johnson, G. O. (Eds.). (1975). Education of exceptional children and youth (3rd ed.). Englewood Cliffs, NJ: Prentice-Hall.

Daines, D. (1983). Trial programs. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 44-45.

Department of Health and Social Security (United Kingdom). (1983). Communication aids centres. (information sheet). London: Department of Health and Social Security.

DES. (1978). Report of the committee of enquiry into the education of handicapped children and young people (Warnock Report). London: Her Majesty's Stationery Office.

Doe, B. (1981, May 22). With the future at their fingertips: Report on how microcomputers help children with special needs. New York Times Education Supplement, p. 9.

Doerr, C. (1979). Microcomputers and the 3 r's: A guide for teachers. Rochelle Park, NJ: Hayden

Duncan, F. (1983). Exploiting voice synthesis. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 57.

Dyke, B. (1983a). The SEMERCs: Manchester. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 23.

Dyke, B. (1983b). Toys to stimulate young minds. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 26.

Easton, J. & Enderby, P. (1983). The acquisition of aids for the speech impaired. (pamphlet). Bristol, England: Assistive Communications Aids Centre, Frenchay Hospital.

Education Act 1981, Chapter 60. (1981). London: Her Majesty's Stationery Office.

Excerpts from justices' opinions in case of deaf girl and school district. (1982, June 29). New York Times, pp. B4-B5.

Foulds, R. A. (1982). Applications of microcomputers in the education of the physically disabled child. Exceptional Children, 49, 155-161.

Fraser, D. (1973). The evolution of the British welfare state: A history of social policy since the Industrial Revolution. New York: Barnes & Noble.

Freeman, D. (1983). Fulfilled needs. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 59.

Geoffrion, L. D. (1981-1982). Computer-based exploratory learning systems for handicapped children. Journal of Educational Technology Systems, 10, 125-132.

Goldenberg, E. P. (1982). Logo--A cultural glossary. BYTE: The Small Systems Journal, 7(8), 210-228.

Goldenberg, E. P. (1979). Special technology for special children: Computers to serve communication and autonomy in the education of handicapped children. Baltimore, MD: University Park Press.

Goode, E. (1984). Sociology. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Gray, R. A. & Mesat, L. J. (1982-1983). Instructional values of microcomputers for handicapped children. Journal of Educational Technology Systems, 11, 35-41.

Greenhouse, L. (1982, June 29). Schools backed on limiting aid to handicapped. New York Times, pp. 1B+.

Greenwood, P. (1983). The SEMERCs: Bristol. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 25.

Grubb, J. (1982). Special education for children below compulsory school age. Early Childhood Development and Care, 9, 283-315.

Head, P. & Poon, P. (1983). Communication in an educational setting. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 32.

Henderson, B. (1983). MAISE--A new approach. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 50-51.

Hindis, R. (1983). New-found opportunities. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 30.

Hofmeister, A. M. (1982). Microcomputers in perspective. Exceptional Children, 49, 115-121.

Hogg, B. (1984). Microcomputers and special educational needs: A guide to good practice. (pamphlet). Stratford-upon-Avon, England: National Council for Special Education.

Holtzman, W. H. (1970). Computer-assisted instruction, testing, and guidance. New York: Harper & Row.

Inner London Education Authority Resource Centre for Motor and Associated Communication Handicaps. (1983). Information sheet.

Johnson, A. B. & Ward, M.E. (1982). An alternative approach to educating the learning-disabled adolescent. The Clearing House, 56(9), 38-43.

Kirk, S. A. & Gallagher, J. J. (1979). Educating exceptional children (3rd ed.). Boston: Houghton Mifflin.

Kitchen, T. (1983). Simple additions. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 40-41.

Kleiman, D. (1982, June 29). Effect of handicapped ruling unclear. New York Times, p. B5.

Kramnick, I. (Ed.). (1979). Is Britain dying? Perspectives on the current crisis. Ithaca, NY: Cornell University Press.

Last, J. (1982, September 10). Means to independence. New York Times Education Supplement, p. 44.

Lawler, R. W. (1982). Designing computer-based microworlds. BYTE: The Small Systems Journal, 7(8), 138-160.

Lemmons, P. (1982). Logo update. BYTE: The Small Systems Journal, 7(8), 334-340.

Mahon, P. (1983). A personal view. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 18-21.

Marsh, P. (1983). The way ahead? Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 16-17.

Marwick, A. (1982). British society since 1945. London: A. Lane.

McDonald, E. T. & Schultz, A. R. (1980). Communication boards for cerebral-palsied children. Journal of Speech and Hearing Disorders, 38, 73-88.

Merton, A. (1983). Computers in the classroom. Technology Illustrated, 3(9), 38-46.

Microelectronics Education Programme. (1984). Primary information. (information sheet). London: Microelectronics Education Programme.

Microelectronics Education Programme. (1983). Special education. (information sheet). London: Microelectronics Education Programme.

Microelectronics Education Programme. (nd[a]). Microelectronics education programme: The programme. (information sheet). London: Microelectronics Education Programme.

Microelectronics Education Programme. (nd[b]). Microelectronics education programme: The SEMERCs. (information sheet). London: Microelectronics Education Programme.

Morgan, H. (1983). From strength to strength. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 60-61.

Morrison, S. (1980, November 17). Extending the body to free the mind. Maclean's, 93, pp. 60-61.

Muller, J. H. (1982). Young people's LOGO association. BYTE: The Small Systems Journal, 7(8), 333-334.

Myatt, J. & Warrington, K. (1983). A view from the classroom. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 42-43.

Office of Technology Assessment. (1982). Technology and handicapped people. (pamphlet). Washington, DC: U.S. Government Printing Office.

Papert, S. (1980). Mindstorms: Children, computers, and powerful ideas. New York: Basic Books.

Papert, S.; Watt, D.; diSessa, A.; and Weir, S. (1979). Final report of the Brookline LOGO project: Part II project summary and data analysis. Artificial Intelligence Memo No. 545. LOGO Memo No. 53. Cambridge, MA: Massachusetts Institute of Technology.

Papert, S. & Weir, S. (1978). Information prosthetics for the handicapped. Artificial Intelligence Memo No. 496. LOGO Memo No. 51. Cambridge, MA: Massachusetts Institute of Technology.

Perlman, R. (1974). Tortis: Toddler's own recursive turtle interpreter system. LOGO Memo No. 9. Cambridge, MA: Massachusetts Institute of Technology.

Perman, D.. (1977). Change and the churches: An anatomy of religion in Britain. London: The Bodley Head.

Proudfoot, M. M. (1974). British politics and government 1951-1970: A study of an affluent society. London: Faber & Faber.

Ragghianti, S. & Miller, R. (1982). The microcomputer and special education management. Exceptional Children, 49, 131-135.

Rees, S. (1983a). Adapting programs for external switches. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 34-35.

Rees, S. (1983b). The Lancasterian project. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 62.

Richards, C. (1983). The SEMERCs: Newcastle. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 22-23.

Rockart, J. F. & Morton, M. S. S. (1975). Computers and the learning process in higher education: A report prepared for the Carnegie commission on higher education. New York: McGraw-Hill.

Sandhu, J. (1983). The use of microelectronics in the education of ESN(S) children. Newcastle upon Tyne: Handicapped Persons Research Unit, Newcastle upon Tyne Polytechnic.

Sicoli, T. R. (1982). Computers and the special education classroom. BYTE: The Small Systems Journal, 7(8), 270-274.

Siegel, E. (1969). Special education in the regular classroom. New York: John Day.

Silverman, F. (1980). Communication for the speechless: An introduction to nonvocal communication systems for the severely communicatively handicapped. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Smith, I. C. H. (Ed.). (1982). Microcomputers in education. Chichester, West Sussex, England: Ellis Horwood.

Smith, R. M. & Neisworth, J. T. (1975). The exceptional child: A functional approach. New York: McGraw-Hill.

Solomon, C. (1982). Introducing Logo to children. BYTE: The Small Systems Journal, 7(8), 196-208.

Spencer, D. (1982, February 12). For Lee and Alan, getting it right is their PET subject. New York Times Education Supplement, p. 14.

Stillard, C. K. (1982). Computers and education for exceptional children: Emerging applications. Exceptional Children, 49, 102-104.

Staples, I. (1983). Special keyboards. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 41.

Staples, I. (1982, September 10). Keyboard skills. New York Times Education Supplement, pp. 44+.

Swann, W. (Ed.). (1981). The practice of special education. London: The Open University.

Taber, F. M. (1983). Microcomputers in special education: Selection and decision making process. Reston, VA: The Council for Exceptional Children.

Tait, J. (1983). The SEMERCs: Redbridge. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 24-25.

Terzian, A. & Thompson, S. (1982). Winner: Disabled but determined. Community and Junior College Journal, 53(11), 39-40.

Thomas, J. L. (Ed.). (1981). Microcomputers in the schools. Phoenix, AZ: The Oryx Press.

Townsend, P. (1981, January 16). How the Tories broke a pledge to the disabled. New Statesman, 101, pp. 3-4.

Valente, J. A. (1983). Creating a computer-based learning environment for physically handicapped children. PhD. dissertation, Massachusetts Institute of Technology, Department of Mechanical Engineering.

Vanderheiden, G. (1982). Computers can play a dual role for disabled individuals. BYTE, 7(9), 136-162.

Watt, D. (1982). Logo in the schools. BYTE: The Small Systems Journal, 7(8), 116-134.

Weir, S. (1981). LOGO as an information prosthetic for the handicapped. Artificial Intelligence Working Paper No. 9. Cambridge, MA: Massachusetts Institute of Technology.

Weir, S. (1979). The evaluation and cultivation of spatial and linguistic abilities in individuals with cerebral palsy. Artificial Intelligence Memo No. 570. LOGO Memo No. 55. Cambridge, MA: Massachusetts Institute of Technology.

Weir, S., Russell, S. J., & Valente, J. A. (1982). Logo: An approach to educating disabled children. BYTE: The Small Systems Journal, 7(9), 342-360.

West, T. (1983). Special lessons for everyone. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 63.

Wiener, M. J. (1981). English culture and the decline of the industrial spirit, 1850-1980. Cambridge, England and New York: Cambridge University Press.

Wigley, I. (1983). A helping hand. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 36-37.

Wigley, I. (1983). Crafty computers. Learning to Cope '83: Computers in Special Education, (an Educational Computing special issue), 37-39.